CLAIMS

1. An isolated EphA3 HLA class II-binding peptide comprising a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7 which binds an HLA class II molecule, or a functional variant thereof comprising one or more amino acid additions, substitutions or deletions.

2. The isolated HLA class II-binding peptide of claim 1, wherein the isolated peptide consists of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7, or a functional variant thereof.

3. An isolated EphA3 HLA class II-binding peptide comprising the amino acid sequence of SEQ ID NO:53, or a functional variant thereof which binds HLA class II molecules comprising one or more amino acid additions, substitutions or deletions.

4. The isolated HLA class II-binding peptide of claim 3 wherein the isolated peptide comprises an amino acid sequence selected from the group consisting of SEQ ID NO:51, SEQ ID NO:54, SEQ ID NO:62, fragments thereof, and functional variants thereof.

5. The isolated HLA class II-binding peptide of claim 1 or claim 3, wherein the isolated peptide comprises an endosomal targeting signal.

6. The isolated HLA class II-binding peptide of claim 5, wherein the endosomal targeting signal comprises an endosomal targeting portion of a polypeptide selected from the group consisting of human invariant chain Ii and LAMP-1.

7. The isolated HLA class II-binding peptide of claim 1 or claim 3 wherein the isolated peptide is non-hydrolyzable.

8. The isolated HLA class II-binding peptide of claim 7 wherein the isolated peptide is selected from the group consisting of peptides comprising D-amino acids, peptides comprising a -psi[CH_2NH]-reduced amide peptide bond, peptides comprising a -psi[$COCH_2$]-ketomethylene peptide bond, peptides comprising a

-psi[CH(CN)NH]-(cyanomethylene)amino peptide bond, peptides comprising a -psi[$CH_2CH(OH)$]-hydroxyethylene peptide bond, peptides comprising a -psi[CH_2O]-peptide bond, and peptides comprising a -psi[CH_2S]-thiomethylene peptide bond.

9. An isolated EphA3 HLA class I-binding peptide comprising a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7 which binds an HLA class I molecule, or a functional variant thereof comprising one or more amino acid additions, substitutions or deletions.

10. A composition comprising an isolated EphA3 HLA class I-binding peptide and an isolated EphA3 HLA class II-binding peptide.

11. The composition of claim 10, wherein the EphA3 HLA class I-binding peptide and the EphA3 HLA class II-binding peptide are combined as a polytope polypeptide.

12. The composition of claim 10, wherein the isolated EphA3 HLA class II-binding peptide comprises an amino acid sequence selected from the group consisting of SEQ ID NO:51, SEQ ID NO:53, SEQ ID NO:54, SEQ ID NO:62, fragments thereof, and functional variants thereof.

13. The composition of claim 10, wherein the isolated EphA3 HLA class II-binding peptide comprises an endosomal targeting signal.

14. The composition of claim 13, wherein the endosomal targeting signal comprises an endosomal targeting portion of a polypeptide selected from the group consisting of human invariant chain Ii and LAMP-1.

15. An isolated nucleic acid encoding a peptide selected from the group consisting of the peptide of any of claims 1-6 or 9, wherein the nucleic acid does not encode full length EphA3.

16. The isolated nucleic acid of claim 15, wherein the nucleic acid comprises a fragment of a nucleotide sequence selected from the group consisting of SEQ ID NO:2, SEQ ID NO:4,

SEQ ID NO:6, SEQ ID NO:52, and fragments of SEQ ID NO:52.

17. An expression vector comprising the isolated nucleic acid of claim 16 operably linked to a promoter.

18. The expression vector of claim 17 further comprising a nucleic acid which encodes an HLA-DR11 molecule.

19. A host cell transfected or transformed with an expression vector selected from the group consisting of the expression vector of claim 17 and the expression vector of claim 18.

20. A host cell transfected or transformed with the expression vector of claim 17, wherein the host cell expresses an HLA-DR11 molecule.

21. A method for enriching selectively a population of T lymphocytes with T lymphocytes specific for an EphA3 HLA binding peptide comprising:

contacting a source of T lymphocytes which contains a population of T lymphocytes with an agent presenting a complex of the EphA3 HLA binding peptide and an HLA molecule in an amount sufficient to selectively enrich the population of T lymphocytes with the T lymphocytes specific for an EphA3 HLA binding peptide.

22. The method of claim 21, wherein the agent is an antigen presenting cell contacted with an EphA3 protein or an HLA class II binding fragment thereof.

23. The method of claim 21 wherein the HLA molecule is an HLA-DR11 molecule and wherein the EphA3 HLA binding peptide is selected from the group consisting of (i) peptides which consist of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7, (ii) peptides which comprise the amino acid sequence of SEQ ID NO:53 or SEQ ID NO:62, and (iii) functional variants of the peptides of (i) and (ii).

24. The method of claim 23, wherein the EphA3 HLA binding peptide comprises an

endosomal targeting portion of a polypeptide selected from the group consisting of human invariant chain Ii and LAMP-1.

25. A method for diagnosing a disorder characterized by expression of EphA3 comprising:

contacting a biological sample isolated from a subject with an agent that is specific for the EphA3 HLA binding peptide, and

determining the interaction between the agent and the EphA3 HLA binding peptide as a determination of the disorder.

26. The method of claim 25 wherein the EphA3 HLA binding is selected from the group consisting of (i) peptides which consist of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7, (ii) peptides which comprise the amino acid sequence of SEQ ID NO:53 or SEQ ID NO:62, and (iii) functional variants of the peptides of (i) and (ii).

27. A method for diagnosing a disorder characterized by expression of an EphA3 HLA binding peptide which forms a complex with an HLA molecule, comprising:

contacting a biological sample isolated from a subject with an agent that binds the complex; and

determining binding between the complex and the agent as a determination of the disorder.

28. The method of claim 27 wherein the HLA molecule is an HLA-DR11 molecule and the EphA3 HLA binding peptide is selected from the group consisting of (i) peptides which consist of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7, (ii) peptides which comprise the amino acid sequence of SEQ ID NO:53 or SEQ ID NO:62, and (iii) functional variants of the peptides of (i) and (ii).

29. A method for treating a subject having a disorder characterized by expression of EphA3, comprising:

administering to the subject an amount of an EphA3 HLA binding peptide sufficient to

ameliorate the disorder.

30. The method of claim 29, wherein the EphA3 HLA binding peptide is selected from the group consisting of (i) peptides which consist of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7, (ii) peptides which comprise the amino acid sequence of SEQ ID NO:53 or SEQ ID NO:62, and (iii) functional variants of the peptides of (i) and (ii).

31. The method of claim 30, wherein the EphA3 HLA binding peptide comprises an endosomal targeting portion of a polypeptide selected from the group consisting of human invariant chain Ii and LAMP-1.

32. A method for treating a subject having a disorder characterized by expression of EphA3, comprising:

administering to the subject an amount of an EphA3 HLA class I binding peptide and an amount of an EphA3 HLA class II binding peptide sufficient to ameliorate the disorder.

33. The method of claim 32, wherein the EphA3 HLA class I binding peptide and the EphA3 HLA class II binding peptide are combined as a polytope polypeptide.

34. The method of claim 32, wherein the EphA3 HLA class II binding is selected from the group consisting of (i) peptides which consist of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7, (ii) peptides which comprise the amino acid sequence of SEQ ID NO:53 or SEQ ID NO:62, and (iii) functional variants of the peptides of (i) and (ii).

35. The method of claim 34, wherein the EphA3 HLA class II binding peptide comprises an endosomal targeting portion of a polypeptide selected from the group consisting of human invariant chain Ii and LAMP-1.

36. A method for treating a subject having a disorder characterized by expression of EphA3, comprising:

administering to the subject an amount of an agent which enriches selectively in the subject the presence of complexes of an HLA molecule and an EphA3 HLA binding peptide, sufficient to ameliorate the disorder.

37. The method of claim 36 wherein the HLA molecule is an HLA-DR11 molecule and the EphA3 HLA binding peptide consists of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7.

38. The method of claim 36, wherein the agent comprises an EphA3 HLA class II binding peptide.

39. The method of claim 38, wherein the EphA3 HLA class II binding is selected from the group consisting of (i) peptides which consist of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7, (ii) peptides which comprise the amino acid sequence of SEQ ID NO:53 or SEQ ID NO:62, and (iii) functional variants of the peptides of (i) and (ii).

40. The method of claim 39, wherein the EphA3 HLA class II binding peptide comprises an endosomal targeting portion of a polypeptide selected from the group consisting of human invariant chain Ii and LAMP-1.

41. A method for treating a subject having a disorder characterized by expression of EphA3, comprising:

administering to the subject an amount of autologous T lymphocytes sufficient to ameliorate the disorder, wherein the T lymphocytes are specific for complexes of an HLA molecule and an EphA3 HLA binding peptide.

42. The method of claim 41 wherein the HLA molecule is an HLA-DR11 molecule and wherein the EphA3 HLA binding peptide is selected from the group consisting of (i) peptides which consist of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7, (ii) peptides which comprise the amino acid sequence of SEQ ID NO:53 or SEQ ID NO:62, and (iii) functional variants of the peptides of

(i) and (ii).

43. A method for identifying functional variants of an EphA3 HLA binding peptide, comprising

selecting an EphA3 HLA binding peptide, an HLA binding molecule which binds the EphA3 HLA class II binding peptide, and a T cell which is stimulated by the EphA3 HLA binding peptide presented by the HLA binding molecule;

mutating a first amino acid residue of the EphA3 HLA binding peptide to prepare a variant peptide;

determining the binding of the variant peptide to HLA binding molecule and the stimulation of the T cell, wherein binding of the variant peptide to the HLA binding molecule and stimulation of the T cell by the variant peptide presented by the HLA binding molecule indicates that the variant peptide is a functional variant.

44. The method of claim 43, wherein the EphA3 HLA binding peptide is selected from the group consisting of (i) peptides which consist of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7, and (ii) peptides which comprise the amino acid sequence of SEQ ID NO:53 or SEQ ID NO:62.

45. The method of claim 43, further comprising the step of comparing the stimulation of the T cell by the EphA3 HLA binding peptide and the stimulation of the T cell by the functional variant as a determination of the effectiveness of the stimulation of the T cell by the functional variant.

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46. An isolated polypeptide which binds selectively a polypeptide of any of claims 1-4 or 9, provided that the isolated polypeptide is not an HLA molecule.

47. The isolated polypeptide of claim 46, wherein the isolated polypeptide is an antibody.

48. The antibody of claim 47, wherein the antibody is a monoclonal antibody.

49. The isolated polypeptide of claim 46, wherein the isolated polypeptide is an antibody

fragment selected from the group consisting of a Fab fragment, a $F(ab)_2$ fragment or a fragment including a CDR3 region selective for an EphA3 HLA binding peptide.

50. An isolated T lymphocyte which selectively binds a complex of an HLA molecule and an EphA3 HLA binding peptide.

51. The isolated T lymphocyte of claim 50 wherein the HLA molecule is an HLA-DR11 molecule and wherein the EphA3 HLA binding peptide is selected from the group consisting of (i) peptides which consist of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7, (ii) peptides which comprise the amino acid sequence of SEQ ID NO:53 or SEQ ID NO:62, and (iii) functional variants of the peptides of (i) and (ii).

52. An isolated antigen presenting cell which comprises a complex of an HLA molecule and an EphA3 HLA binding peptide.

53. The isolated antigen presenting cell of claim 52 wherein the HLA molecule is an HLA-DR11 molecule and wherein the EphA3 HLA binding peptide is selected from the group consisting of (i) peptides which consist of a fragment of an amino acid sequence selected from the group consisting of SEQ ID NO:3, SEQ ID NO:5 and SEQ ID NO:7, (ii) peptides which comprise the amino acid sequence of SEQ ID NO:53 or SEQ ID NO:62, and (iii) functional variants of the peptides of (i) and (ii).

54. A vaccine comprising the polypeptide of any of claims 1-4 or 9 and a pharmaceutically acceptable carrier.

55. The vaccine of claim 54, further comprising an adjuvant.

56. A vaccine comprising a cell selected from the group coinsisting of a T lymphocyte of claims 50 and 51 and an antigen presenting cell of claims 52 and 53, and a pharmaceutically acceptable carrier.

57. The vaccine of claim 56, further comprising an adjuvant.

58. A vaccine comprising the nucleic acid of any of claims 15-18 and a pharmaceutically acceptable carrier.

59. The vaccine of claim 58, further comprising an adjuvant.

60. An isolated functional variant of an EphA3 HLA binding peptide identified by the method of claim 43.

61. The isolated functional variant of claims 60, wherein the functional variant comprises the amino acid sequence of SEQ ID NO:62 or a fragment thereof.

62. A method for identifying genes encoding antigens presented by MHC class II molecules, comprising

providing a cDNA library in an expression plasmid containing the EBV origin of replication,

cotransfecting the library and nucleic acid molecules coding for class II transactivator and for the relevant HLA class II chains of the MHC class II molecule into 293-EBNA1 cells or other cells expressing EBV nuclear antigen,

contacting the cotransfected cells with a T cell, and

determining the recognition of the cotransfected cells by the T cell.

63. The method of claim 62, wherein the step of cotransfecting further comprises cotransfecting the cells with a nucleic acid molecule coding for invariant chain Ii.

64. The method of claim 62, wherein the step of determining the recognition comprises determining proliferation by the T cell or production of a cytokine by the T cell.